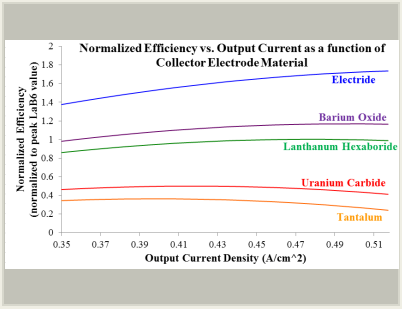
Small Business Innovation Research/Small Business Tech Transfer

A Novel Electrode Material for Thermionic Power Generation, Phase I

Completed Technology Project (2016 - 2016)

Project Introduction

The conversion of heat to power has proven to be vital in flight missions where solar power generation is not an option. Radioisotope thermoelectric generators that converted heat produced by a decaying nuclear source to power have been used on missions such as Cassini, New Horizons, Galileo, Ulysses and the Mars Science Laboratory. Although never flown by the United States, thermionic converters have also been investigated for space applications. Their improved efficiency over thermoelectric generators makes them an attractive option, but the high operating temperatures required have thus far been a significant obstacle to their use. Thermionic generators convert heat energy directly into electrical power. An emitter electrode on a heat source emits electrons across a vacuum gap to a cold electrode. The generated current is pumped through a load where it can do useful work before it is returned to the emitter. Thermionic generators do not use any moving parts or working fluid, which results in highly reliable devices that do not need frequent maintenance. Unlike thermoelectric generators, which have exhibited efficiencies only up to about 8%, state-of-the-art thermionic generators operate with efficiencies approaching 20%. This proposal seeks to study the use of the nanomaterial C12A7 electride as an electrode material. C12A7 electride has been shown to emit stably at temperatures in excess of 1600 degrees C and has a measured work function between 0.8-2.1 eV. Due to its low work function, C12A7 electride has the potential to greatly improve the efficiency of the state-of-the-art in thermionic energy conversion as well as enable device operation at much lower temperatures than is currently possible. Busek previously has investigated C12A7 electride in thermionic emission configurations for space propulsion hollow cathode applications. In the proposed work, Busek will evaluate the potential benefits of a C12A7 electride thermionic converter electrode.



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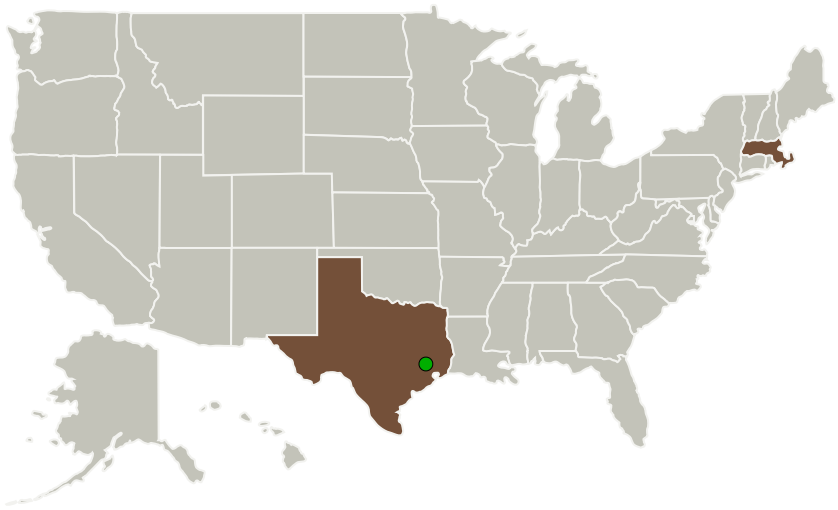
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Busek Company, Inc.	Lead Organization	Industry Women-Owned Small Business (WOSB)	Natick, Massachusetts
Johnson Space Center(JSC)	Supporting Organization	NASA Center	Houston, Texas

Primary U.S. Work Locations	
Massachusetts	Texas

Project Transitions

June 2016: Project Start

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

Busek Company, Inc.

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

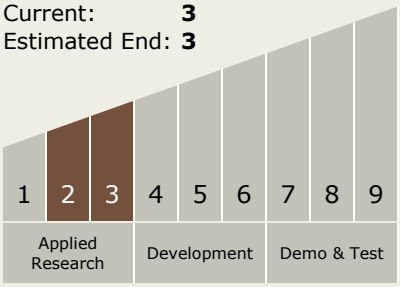
Carlos Torrez

Principal Investigator:

Lauren Rand-lee

Technology Maturity (TRL)

Start: **2**
Current: **3**
Estimated End: **3**



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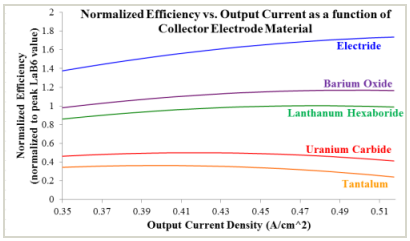
December 2016: Closed out

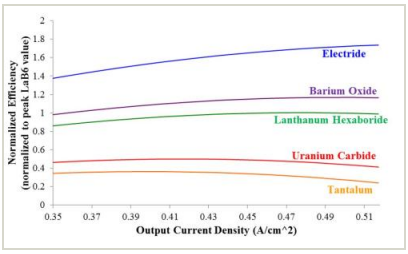
Closeout Documentation:

- Final Summary Chart*(https://techport.nasa.gov/file/140474)*

Images



Briefing Chart Image
A Novel Electrode Material for Thermionic Power Generation, Phase I
(https://techport.nasa.gov/image/126395)



Final Summary Chart Image
A Novel Electrode Material for Thermionic Power Generation, Phase I Project Image
(https://techport.nasa.gov/image/129769)

Technology Areas

Primary:

- TX03 Aerospace Power and Energy Storage
  - TX03.1 Power Generation and Energy Conversion
    - TX03.1.4 Dynamic Energy Conversion

Target Destinations

The Sun, Earth, The Moon, Mars, Others Inside the Solar System, Outside the Solar System